ANSWERS: Acids and Bases

1) a) Equations

Sulfuric acid + sodium hydroxide → sodium sulfate + water

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

b) c) d) Explanations

Beaker one (acid)

The solution would be red to start with as the pH would be 1–2. The ions present in solution would be H^+. The pH would be low as there is a high number of H^+ ions present.

As NaOH is added the solution would go orange, then yellow, then green. When the solution is orange and yellow the pH is still less than 7 as there are still more H^+ than OH^- ions. When the solution becomes green the amount of OH^- ions added (from the NaOH) cancel out the H^+ ions from the sulfuric acid and form water in a neutralisation reaction. At this stage the pH would be 7.

As more NaOH is added the solution then becomes blue and then purple. When the solution is blue the pH is 8 -11 as there are now more OH^- ions present than H^+ ions. When it becomes purple the pH is 13 – 14 as there are now many more OH^- ions present than H^+ ions.

Beaker two (water)

The solution is green initially as water contains equal numbers of H^+ and OH^- ions and is pH 7. As NaOH is added, the solution would become blue (pH 8 - 11) and then purple (pH 13 – 14). Because the water was neutral to start with, as more OH^- ions are added, the solution becomes more basic as the OH^- ions are immediately in excess.

2) a) i) Description of colour changes:

- red/pink to start with blue/purple/violet at end.

ii) Explanation of colour changes:

At the beginning the red indicated a low pH due to excess H^+ ions in the solution.

As the NaOH was added, a yellow/green colour indicates a pH of around 7, due to the OH^- ions combining with the H^+ ions to form a neutral solution.

As more NaOH is added the blue/purple indicated a pH of 11 plus, due to excess OH^- ions in the solution.

b) Identification of reaction type:

Acid-base (or acid-carbonate) neutralisation (the carbonate ions react with the H^+ ions of the acidic solution and neutralise the solution).

Description of observations:

Bubbling in the solution/fizzing/effervescence/frothing/foaming Ca_2CO_3 disappears.

Linking observations to products:

The products are CO_2, H_2O and a salt. The CO_2 gas causes the bubbles/fizzing/etc.

Writing a word equation:
Nitric acid + sodium carbonate → sodium nitrate + water + carbon dioxide

Writing a symbol equation:

$2HNO_3 + Na_2CO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$

3)
Explains that the fizzing is a resultof carbon dioxide being formed.

$\mathbf{2}NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + \mathbf{2}H_2O + \mathbf{2}CO_2$

Explains that the fizzing (effervescence) is a result of carbon dioxide being formed.
Explains that the Na_2SO_4 is soluble, so final solution is colourless.

4)
$[H^+] = [OH^-]$ / $H^+ + OH^- \rightarrow H_2O$

At the beginning the solution is red / orange due to the H_2SO_4 and U.I. At neutralisation the solution turns yellow-green / green.

Sodium hydroxide + sulfuric acid → sodium sulfate + water

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Neutralisation is when a salt and water are produced because the amount of acid = the amount of base. The NaOH increases the pH towards 7 by cancelling out the acid.

Neutralisation is when the products of the reaction are pH 7 and (as the amount of H_30^+ = the amount of OH^-) the amount of acid equals the amount of base (when
pH = 7 = $[H_30^+][OH^-]$).

At the beginning the solution is red due to the H_2SO_4. At neutralisation it is yellow-green / green due to the Na_2SO_4 and H_2O (or no H_2SO_4) present.

Explains clearly how they would ascertain neutralisation using an appropriate indicator, eg. Add a few drops of Universal Indicator solution. Monitor colour changes as reaction proceeds: red in acid → yellow-green / green when neutral.

5) a)

Estimated pH	Colour when tested with Universal indicator
	(i) red
(ii) 8 – 12	
	(iii) yellow/orange
(iv) 7	

b) Sodium hydrogen carbonate + hydrochloric acid → carbon dioxide + sodium chloride + water

$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

At pH 6.5 the pool water is too acidic so sodium hydrogen carbonate is added to raise the pH back to the ideal region of pH 7 to 7.6 as it is a base and it neutralises the acid.

6) a) i) magnesium sulfate sulfuric acid

ii) iii) sulfuric acid + magnesium hydroxide → magnesium sulfate + water

b) Products of the reaction are neutral as the amount of H_3O^+ = amount of OH^-

7) The one that fizzes with acid is the carbonate **OR** The one that doesn't fizz is the oxide.
Do not accept any mention of the oxide producing a gas as an Achievement statement, nor the use of any other equipment or tests.

$Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O$

8) i) carbon dioxide/ CO_2
ii) sulfuric acid + sodium hydrogen carbonate → water + carbon dioxide + sodium sulfate
iii) $H_2SO_4 + 2NaHCO_3 \rightarrow 2H_2O + 2CO_2 + Na_2SO_4$
Carbonates and hydrogen carbonates are bases so this is a neutralisation reaction where the products include a salt and water.
The pH will be around 7 because [H3O+]=[OH-].
A full explanation including products, final pH and balance of ions